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ABSTRACT

The performance of 244 (111 male and 133 female) developmental college students was studied in relation to their perceived levels of mathematics anxiety (123 low and 121 high). The Mathematics Anxiety-Apprehension Survey (MAAS) (T. Ikegulu, 1998) was administered to students in four classes from two institutions. The product limit estimator (Kaplan and Miere, 1951) was used to estimate the persistence distributions for the sample. Low mathematics anxiety was consistently related to higher academic performance and the likelihood of persisting. Only gender was a significant factor in students' academic performance. Females were not significantly different in their likelihood of persisting than males. None of the interaction, mathematics anxiety-apprehension, and first-generation (in college) status were statistically significantly related. Implications for developmental instruction of these correlates of mathematics anxiety and apprehension are discussed. The MAAS survey is attached. (Contains 2 tables and 57 references.) (SLD)

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The Differential Effects of Gender and Mathematics Anxiety-Apprehension

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On Developmental Students' Academic Performance and Persistence

Abstract

The performance of 244 (111 male and 133 female) developmental students was studied in relation to their perceived level of mathematics anxiety (123 Low and 121 High). Participants' inc? ?ion into the study was strictly voluntary. The "Mathematics Anxiety-Apprehension Survey (MAAS; Ikegulu, 1998)" was administered to students in four classes differing in composition and content from two institutions. The product limit Kaplan-Miere (Kaplan & Miere, 1951) estimator was employed to estimate the persistence distributions for the sample. Low mathematics anxiety-apprehension was consistently related to higher academic performance and the likelihood to persist. Mathematics anxiety-apprehension was found to be inversely related ($r = -0.458$, $p < 0.001$).

Only gender ($F[1, 240] = 5.76$, $p < 0.05$) was a significant factor in students' academic performance. Females (46.62%) were not significantly different in their likelihood for persistence than males (45.95%). None of the interaction, mathematics anxiety-apprehension, and first-generation status were significant. Students who reported high levels of mathematics anxiety-apprehension also had lower mean college GPA and persistence time. First-generation (51.65%) had higher persistence than non-first-generation (43.14%) students. Overall, low anxious-apprehensive students had higher mean academic performance and persistence time; and had the higher propensity for persistence than high anxious-apprehensive students. Implications of mathematics

anxiety as they relates to developmental instruction were discussed.

The Differential Effects of Gender and Mathematics Anxiety-Apprehension On Developmental Students' Academic Performance and Persistence

Introduction

One common complaint offered by developmental students who do poorly in college is that they experience high levels of state and/or test anxiety which impairs their ability to perform well when evaluated. The complaint is sometimes discounted by some who view such statements as a "cop-out" for poor performance. The theoretical framework for the present investigation consisted of two interrelated theories: "Study-Skills Deficit" and "Cognitive-Attentional Interference." Both theories are often discussed under the pragmatic frameworks of the Deficiency and General Test Anxiety and, the Interference and State Anxiety models.

The deficiency and general test anxiety model posits that mathematics anxiety (and apprehension) disrupts cognitive activities at several stages , affects test performance, depresses motivation, and prohibits the application of appropriate study skills and mental models (Dew, Galassi, & Galassi, 1983, 1984; Fennema & Sherman, 1976, 1978; Stage & Kloosterman, 1995; Zyl & Lohr, 1994). The interference and state anxiety model, on the other hand, purports that mathematics anxiety (and apprehension) interferes with cognitive reasoning, alters recall, and induces physiological symptoms and signs in students. Not only that both models specify that performance is affected by different types and levels of anxiety, they also stipulate that at the time of the examination, test takers have different knowledge structures (Cavallaro & Meyers, 1986; Dendato & Diener, 1986; Holahan, 1980; McKeachie, Pintrich, & Lin, 1985). The extent

to which mathematics anxiety-apprehension affects students' retention has not been studied.

The purpose of this study was to determine the differential effects of gender and the perceived levels of mathematics anxiety-apprehension (Low and High) on students' academic performance (college cumulative GPA) and likelihood to persist. Two hypotheses were proposed: (1) Based on the gender bias in favor of female students in higher education, I hypothesized that female students would have higher mean GPA, persistence time, and persistence distribution than male students. (2) With regards to students' levels of mathematics anxiety-apprehension, I also proposed that students with perceived low mathematics anxiety-apprehension would not have the same mean persistence time, academic achievement, and persistence distribution as those with high perceived levels of mathematics anxiety-apprehension regardless of their first-generation status and gender (Nora & Cabrera, 1996).

Pedagogical Roots of Anxiety and Apprehension

The literature on the relationships between mathematics anxiety and apprehension and, scholastic achievement can hardly be considered encouraging. Evidence abounds on general and state anxiety but not on mathematics anxiety-apprehension and its correlates. After several decades of research, the most widely recognized measures of mathematics anxiety-apprehension have been found to correlate with academic achievement only in an inconsistent manner, but the correlation never exceeded 0.50 (Boli, Allen, & Payne, 1985; Green, 1990; Handel, 1986; Ma & Kishor, 1997; Perry, 1981). While there are many reasons for the lack of substantial and consistent relationship in the education literature, one potential explanation is the almost

exclusive reliance on the assessment of mathematics anxiety-apprehension which operationalized anxiety traits as generalized dispositions rather than situational dispositions (Dew, Galassi, & Galassi, 1983, 1984; Fennema & Sherman, 1976, 1978; Stage & Kloosterman, 1995; Zyl & Lohr, 1994). Operationally, this means that earlier measures of mathematics anxiety-apprehension were developed to apply across many situations rather than in a single situation and/or content. The present investigation focused on two dimensions in educational settings: (1) Mathematics Anxiety and (2) Mathematics Apprehension. Both dimensions are discussed within the pedagogical underpinnings of instructional and/or classroom anxiety as they relate to communication and writing apprehension and anxiety and, general and state anxiety as they relate to mathematics anxiety-apprehension (Dandato & Dieber, 1986; Ikegulu, 1998).

Communication and Writing Apprehension and Anxiety

Mathematics is not the only discipline to recognize anxiety and its detrimental effects on students' performance. Anxiety and apprehension have plagued students' written composition and essays for the past six decades. Within the past four decades, a number of investigators (e.g., Clevenger, 1959; Friedrich, 1970; Phillips, 1968; Phillips & Metzger, 1973) in the field of speech communication have examined the role of anxiety and apprehension as they relate to interpersonal communication and human interaction. The conclusion from these investigations is that communication apprehension is a pervasive trait that seriously affects a large number of individuals.

Daly and Shamo (1978) offered the best definition of this phobia. The highly apprehensive individuals are those for whom their anxiety about communication out-weighs their

projection of gains from such situations. That is, the highly apprehensive individuals have the tendency to avoid communication situations or react in some anxious manner if compelled because they foresee primarily negative consequences from such engagements. Specific research findings have indicated that highly apprehensive individuals have the potential to be less motivated to achieve and generally engage in less self-disclosure (Giffin & Gilham, 1971; Hayes, Hatch, & Silk, 1996). Furthermore, they also tend to select occupations that they perceive to have minimum communication and are likely to chose housing and seating positions that require less communication (Daly & Shamo, 1976, 1978). High communication apprehensives seldom engage in group dynamics and when forced to, contribute very little to the group (Daly, 1981; Daly & Shamo, 1976, 1978). As one would expect, research has also demonstrated that individuals who have such apprehension tend to exhibit low self-concept, which in turn is often reflected and reinforced by those they interact with and ratings they received (Karst & Most, 1973; Shrewsbury, 1995).

Writing is one of the means of communication and has been of national concern, particularly since the writing skills of students have diminished. The decline in college students' writing quality can be attributed to the presence of communication apprehension and the absence of verbal precision in television, advertising, and political language (Connors & Lunsford, 1993; Schultz & Meyers, 1981; Shrewsbury, 1995). It is also due to the lack of writing practice in high school English courses, underprepared English Teachers, and the difficulties involved in evaluating students' writing (Cullum, 1991; Daly, 1978a, 1978b; Daly & Shamo, 1978). In addition, writing instructors who detected a deficiency in the writing skills of entering freshmen

indicated that students had decreased in communication of logical ideas, development and construction of grammatical sentences, spelling, organization and coherence of the total composition, and punctuation (Cullum, 1991; Daly, 1978a, 1978b; Daly & Shamo, 1978; Dandato & Dieber, 1986; Hayes, 1981; Hayes, et al., 1996; Thompson, 1979, 1981).

For the past 30 years, the psychosocial construct writing apprehension has been of particular interest to researchers, writing instructors, and educators at-large. Consequently, an abundance of empirical studies have examined writing apprehension to determine its impact on the writing skills of students. Studies have revealed that writing anxiety is a consequence of high writing apprehension. John Daly, one of the major proponents leading the field of research on writing apprehension, is responsible for coining the term writing apprehension: "A situation and subject specific individual difference associated with a person's tendencies to approach or avoid situations perceived to potentially require writing accompanied by some amount of perceived evaluation" (Daly, 1981, p. 10).

With regards to writing, students are labeled as either high or low apprehensives. High apprehensives tend to find writing unrewarding and punishing while low apprehensives find it rewarding and enjoyable. More specifically, high apprehensives tend to avoid situations requiring writing, which to a large extent reduces their opportunities for practice which is crucial to the development of writing skills. In general, high apprehensives perform lower on standardized tests of writing skills and abilities than do low apprehensives; and are less likely to succeed in a variety of academic subject areas than their low apprehensive counterparts. While low apprehensives write more and use more qualifications, high apprehensives tend to write less,

use fewer qualifications, usually choose a lower level of vocabulary, and lack creativity (Clifford, 1978, 1981; Connors & Lunsford, 1993).

Studies have linked writing apprehension to self-esteem (Daly, 1977, 1978b); message intensity, sex differences, and SAT scores (Daly & Miller, 1975b; Daly & Shamo, 1976); success expectations, and willingness to take advanced courses (Daly & Miller, 1975a, 1975b; Daly & Shamo, 1978); and academic and occupational choices, decisions, and preferences (Daly & Shamo, 1976, 1978). However, much of the research has focused on writing apprehension and students' writing performance in terms of writing aptitude, writing ability, and language intensity (Clifford, 1981; Faigley, Daly & Witte, 1981; Hayes, 1981). Few of these studies were devoted to writing apprehension and anxiety.

Anxiety about writing is perhaps the most common form of writing deficit that both experienced and inexperienced students will encounter when composing. The causes of writing anxiety vary from neurological problems that underlie language processing, poor skill development, and inadequate role models to lack of an understanding of the composing process and an authoritative, teacher-centered, product-based mode of teaching. Overall, researchers argue that writing anxiety stems from a student's previous academic success. Although the symptoms are all too familiar, a number of studies have examined the causes and predictable effects of writing anxiety in order to help improve the writing skills of college students (Clifford, 1978, 1981; Connors & Lunsford, 1993; Schultz & Meyers, 1981; Shrewsbury, 1995). Writing apprehension-anxiety is related to test anxiety in ways that mathematics apprehension-anxiety is to state anxiety.

General and State Anxiety

Mathematics anxiety is considered to be related to test anxiety, and worry and emotionality are considered the most stable component of general and state anxiety (Dew, et al., 1983/84). Contemporary anxiety-apprehension theory and research have posited and maintained that apprehension is a perceptual disposition, that apprehension is antecedent to anxiety, and that anxiety is a multifaceted emotion that has the potential to disrupt cognitive activities at several stages of the information processing (Clevenger, 1959; Daly, 1977, 1981; Daly & Miller, 1975b; Daly & Shamo, 1976, 1978; Deffenbacher, 1982; McKeachie, Pintrich, & Lin, 1985; Meyers & Martin, 1974; Sarason, 1985).

Anxiety may affect test performance (and ability) by interfering with test preparation and study habits. Students who are generally anxious about taking a test may fail to use appropriate test-taking strategies and study skills to: (1) direct their attention to relevant information, (2) integrate information in memory, (3) assess their learning state through self-evaluation, and (4) believe in their mental models (Barham & Ikegulu, 2000; Culler & Holahen, 1980; McKeachie, et al., 1985). Another theoretical account of the relationship between anxiety-apprehension and performance proposes that anxiety-apprehension interferes with cognitive activities at the time of the evaluation. Anxious students may become preoccupied with and apprehensive and/or worry about their performance and these intrusive thoughts may undermine the students' self-esteem, interfering with their ability to sustain attention to task-relevant instructional materials; thereby, preventing the students from engaging in cognitive operations (e.g., following instructions, use

of a variety of logical rules, and recall) that would facilitate test performance (Deffenbacher, 1982; Sarason, 1985). Mathematics is a cognitive process that requires attention-to-details and perseverance. Students with high mathematics apprehension are likely to be high in mathematics anxiety (Barham & Ikegulu, 1999; Ikegulu, 1998).

Methodology

The Mathematics Anxiety-Apprehension (MAAS, Ikegulu, 1998) was administered to 244 students enrolled in Basic/Developmental Mathematics from two institutions. Students also filled out a Demographic Survey questionnaire that solicited students' gender, classification, year-of-college admission (YOA) and expected date of graduation (YOG), family background and size, number of siblings in or attended college, and composite ACT/SAT score. Students were classified as either Low-Anxiety-Apprehension (MAAS score less than or equal to sample MAAS mean score) or High-Anxiety-Apprehension (MAAS score greater than the sample MAAS mean score). Students were also classified as Low-Performer (GPA less than or equal to 2.00) or High-Performer (GPA greater than 2.00). An event indicator was created whereby: (1) Event = 1, if the student was classified as high-anxious-apprehensive and low-performer; (2) Event = 2 if the student was classified as high-anxious-apprehensive and high-performer or, low-anxious-apprehensive and low-performer; and (3) Event = 3, if the student was classified as low-anxious-apprehensive and high-performer. The rationale for dichotomizing mathematics anxiety-apprehension and GPA stemmed from the fact that low-anxiety students tend to have high GPAs; whereas, students with reported high-anxiety have the tendency to exhibit low academic

performance. Furthermore, low-performers have the highest propensity for attrition than high-performers; and the attrition and/or retention patterns tend to differ by gender, first-generation status, and levels of anxiety (Korn & Dorey, 1992; Nora & Cabrera, 1996; Pascarella, et al., 1996; Perry, 1981; Terenzini, et al., 1996). These newly created variables were then used, in addition to gender, as fixed-factor effects with GPA as the dependent variable in the ANOVA procedures.

From the Demographic Survey, persistence time (PTIME in months) was computed as the difference between expected date of college graduation and date of admission into college (i.e., PTIME = (YOG - YOA)). A persistence status indicator (PSTAT) was also created. Students with Event Indicators of 1 or 2 were grouped as 1 (event for the PSTAT); and constituted the events in the persistence analysis. Students with Event Indicator of 3 were recoded as 0 (for the PSTAT); and constituted the censored observations. Both the persistence time and the persistence status were employed in the Kaplan-Miere procedure (Kaplan & Miere, 1951; Kay, 1983/86; Pepe & Mori, 1991).

Results and Discussion

Persistence Analysis

This study adopted the statistical technique often used by clinicians (e.g., Biostatisticans, Epidemiologists, and/or Biometricians) in the study of the etiology of disease occurrence in human populations. The term 'Persistence Analysis' is an amended form of survival analysis with the Kaplan-Miere estimator as its persistence distribution. It is generally used in clinical

trials to study the prevalence and/or incidence of disease occurrence over time; or to differentiate the treatment effectiveness of a particular drug or treatment regimen among several drug-types. The time mater-meter, 'Persistence Time (PTIME or $\hat{S}(t)$),' is useful for continuous time (T). However, if we discretize T by partitioning it (i.e., the total time on study, total risk set, or person-times) into discrete sets with even or uneven time intervals. Then, r_j and n_j would be considered the number of interval events and total interval risk sets respectively (for some $t \in [t_j, t_{j+1}]$). That is, t spans the total interval from t_0 (initial study time) to t_n (end of study time). In this case, all the subjects or participants under investigation at the start of the study or t_0 and stayed (without loss to follow-up) would contribute to the total risk-set or person-time information relevant for the estimation of the persistence (survival) and the force-of-attrition functions (Kalbfeisch & Prentice, 1980; Pepe, 1991; Pepe & Mori, 1993; Peto & Peto, 1972).

The force-of-attrition function conveyed the needed information about the intensity of events occurring through time (Kalbfeisch & Prentice, 1980). Unfortunately, the estimation of hazard function ($\hat{h}(t)$) makes its curve quite difficult to plot directly. So, it is better to assume a fixed interval length and assume that $\hat{h}(t)$ is constant over this interval. If in this interval, there are r_j within interval events and n_j within interval total risk-sets, then, the estimated values of the constant force-of-attrition in the jth interval would be $\hat{h}(t) = r_j/n_j$. Table 1 summarizes these findings with respect to the estimated persistence function (Korn & Dorey, 1992; Pepe, 1991; Peto & Peto, 1972).

Insert Table 1 About Here

The log-rank statistic compared the stratum-specific or group-specific persistence distributions under the null hypothesis of no difference in persistence behaviors across the stratum or groups. The Breslow's statistic provided the differential hazard rates and, the Tarone-Ware statistic compared the concordance or discordance of the Attrition-Free Persisters' and the Attrition Persisters' statistics. There does not seem to be a statistically significant difference in the persistence distributions by gender and first-generation status; neither were their estimated mean

persistence times and retention/attrition rates significantly different over time. The same results were obtained when first-generation status was stratified by gender (Pepe & Fleming, 1989, 1991; Pepe, Longton, & Thornquist, 1991).

Academic Performance

The overall mean (SD) GPA for the entire sample was 2.84 (0.47). The mean (SD) GPA for the sub-samples were: (1) Gender, males (2.75, SD = 0.46) and females (2.92, SD = 0.56); First-generation status, first-generation (2.77, SD = 0.54) and non-first-generation (2.89, SD = 0.57); and (3) Mathematics anxiety, low-anxiety (2.83, SD = 0.53) and high-anxiety (2.86, SD = 0.55). The academic performance for low-anxiety and high-anxiety students were practically the same ($t = -0.037$, $df = 240$, and $p > 0.05$). Mathematics anxiety-apprehension was found to be inversely related to academic performance (Boli, et al., 1985; Green, 1990; Handel, 1986; Ma & Kishor, 1997; Perry, 1981). Female students significantly outperformed male students ($t = -2.59$, $df = 240$, and $p < 0.05$); and had higher (but insignificant mean persistence time) with similar

persistence distribution than male students. First-generation students marginally outperformed non-first-generation students (t = -0.119, df = 240, and p = 0.085); and had higher retention rate and mean persistence time. Students with perceived low mathematics anxiety-apprehension were not different from those with perceived high mathematics anxiety-apprehension in their academic performance, persistence time, and persistence distribution.

Analysis of variance was also performed with students' college cumulative GPA as the dependent variable and, gender, first-generation status (GENERATION), and mathematics anxiety (ANXIETY) as the fixed factor effects. Table 2 is a summary of the ANOVA results.

Results indicated that no interaction effects were observed. The main effects due to mathematics anxiety and first-generation status were also not significant. There was, however, a significant main effects due to gender ($F(1, 240) = 5.76$, $p < 0.05$) with an observed power of 66.7% and 2.3% of variance contribution in the model. The overall model explained about 96.9% (coefficient of attenuation or R^2) of the variance in students' academic performance.

Insert Table 2 About Here

Summary and Conclusion

The overall predictive ability of the model in Table 2 was 97% with an observed power of 0.999. This indicates that about 92.2% of the total variation in students' academic performance was explained by their gender, first-generation status, and perceived levels of mathematics anxiety-apprehension. Gender and first-generation status contributed most of this variance. In

light of the non-significant interaction effects, this means that all possible combinations of levels of gender with those of the first-generation status and mathematics anxiety-apprehension would not affect the inferences thereof, in the application of this instrument in a classroom or an instructional environment (Ikegulu, 1998). Thus, both male and female developmental students would be expected to exhibit different level of mathematics anxiety-apprehension (Stage & Kloosterman, 1995). That is, low-anxious-apprehensive and high-anxious-apprehensive males would be expected to have different academic performance with their female counterparts. However, when considered individually, female developmental students would be more likely to out-perform male developmental students. In addition, students with low mathematics anxiety have the tendency to achieve better, academically, than those with high mathematics anxiety. With regards to the distribution patterns of students' persistence, first-generation male students had the higher propensity for retention than the non-first-generation males students. First-generation and non-first-generation female students had about the same persistence distributions (Pepe, 1991; Pepe, et al., 1991).

Results of the present investigation indicated that: (1) Students' gender was a significant factor ($F[1, 240] = 5.76$, $p < 0.05$) in their academic performance. (2) Students' perceived level of mathematics anxiety-apprehension was not a significant factor ($F[1, 240] = 0.22$, $p > 0.5$) in their academic performance. Low anxious-apprehensive female students had higher mean academic performance and persistence time than low anxious-apprehensive male students. High anxious-apprehensive female students had higher mean academic performance and persistence time than high anxious-apprehensive male students. (3) First-generation students marginally

outperformed non-first-generation students ($t = -0.119$, $df = 240$, and $p = 0.085$), had higher retention rate and mean persistence time, and had non-differential retention rates (See Table 1).

A decade of research on anxiety-apprehension and academic performance indicated that the relationship between them is at most 0.5 (Boli, et al., 1985; Green, 1990; Handel, 1986; Ma & Kishor, 1997; Meyers & Martin, 1974; Perry, 1981; Sarason, 1985). The present investigation found an overall significant negative correlation ($r = -0.458$, $p < 0.001$) between mathematics anxiety-apprehension and academic performance. This means that students with high academic performance experienced low mathematics anxiety-apprehension. When the positive and negative scores on mathematics anxiety-apprehension were correlated with students' high school GPA and college cumulative GPA, both measures were not related to high school GPA. However, the positive measure was found to be inversely related ($r = -0.368$, $p < 0.001$) to college performance and the negative measure positively correlated ($r = 0.452$, $p < 0.001$) with academic performance. These results were expected (Hayes, 1981; Hayes, et al., 1996; Ikegulu, 1997). Positive (and negative) scores on the mathematic anxiety-apprehension tapped on the positive (and negative) aspects about students' perceptions and feelings toward mathematics (Ikegulu, 1998). Thus, the higher the mathematics anxiety-apprehension a student experiences, the lower his or her academic performance and, students with positive (negative) attitudes toward mathematics had higher (lower) academic performance.

Basic mathematics at both the pre-postsecondary and the postsecondary levels place emphases on discovery learning, pedagogical principles, and concept acquisition and mastery of content. The new era in technological advancements demands rigor and expertise, as well as,

conceptualization and the ability to encode/decode information within a short period of time. Individuals are often required to process information in nano-seconds. Naming an occupation where the least mathematical skills are not required is difficult. Although it may not be a differential or an integral calculus or, the derivation of a theorem that is required, most individuals do face the demands of computational skills daily (Barham & Ikegulu, 2000; Perry, 1981).

Given the limited research on mathematics anxiety and apprehension and, the abundance of empirical studies on anxiety and their daily effects on mankind, I suppose there might reasonably exist a general anxiety and/or apprehension about mathematics. It is quite possible that there may be a very large number of the population who fail miserably in an environment where mathematics competencies are in demand because of their apprehension and/or anxiety about the subject. In a very general sense, these are the individuals who fail because they find mathematics very frightening. For instance, students who are high in communication apprehension would likely be unwilling to speak in the public, would have difficulty comprehending and deciphering information, and would also have expression anxiety and receiver apprehension (Daly, 1981; Daly & Shamo, 1978; Hayes, 1981; Perry, 1981; Shrewsbury, 1995).

By the same token, students who are apprehensive about mathematics are likely to be mathematics anxious. Students who are high in their apprehension about mathematics are likely to fear the evaluation of their tests and/or assignments because of an expectant negative rating. Thus, they would avoid mathematics and mathematically related courses and when compelled,

would more likely exhibit high levels of mathematics anxiety. These students expect to fail, and logically they should (and often do) since they seldom engage in the practice of mathematics. In instructional or classroom environments, these are the students who are likely to procrastinate, fail to turn in their assignments, copy their home works in class during class periods on the due dates, always want a take-home test, do not attend class regularly, are always sick during a math test, perform poorly on standardized tests, and enroll involuntarily in courses directly related to mathematics (Ikegulu, 1998). Outside of the instructional or classroom environments, it would not be expected that students who are high in mathematics anxiety-apprehension would engage in extra-curricula activities where computational skills are required. They would tend to seek academic majors and career paths that require the least amount of computational skills; and if per chance, they find themselves in highly structured and mathematically-oriented occupational environments, would resort to truancy, seek alternative occupations or career paths, report being unhappy about their present class and job, and complain. Students who are high in mathematics anxiety-apprehension are also likely to chose non-technical academic minors; and their career choices and/or occupational preferences are also likely to be non-technical. They are likely to be found in occupations that are both action-driven and service-oriented (Ikegulu, 1997, 1998).

Results of this investigation could be rationalized with students' 'academic preparedness hypothesis.' This hypothesis posits that students' previous academic preparation (number and hours of high school mathematics, high school GPA and rank, and high school activities) reflect on their college readiness, performance, and persistence. The significance of gender in this study could be traced to students' high school preparation. More female students enrolled in upper

level mathematics (Algebra I & II) and Advanced Placement courses (Calculus, Statistics, etc.) than male students. Furthermore, the developmental education students' population in high school is the same as in college. This set of students come to higher education with similar academic indicators (study habits, low ACT scores, high attrition rate, and low class attendance) they exhibited in high school. Hence, the rationale for the gender difference and, the non-differential factors due to their perceived levels of mathematics anxiety-apprehension and first-generation status in their academic performance, persistence time, and persistence distribution.

Further investigations should examine the differences between developmental and non-developmental students, and how learning styles may be "good" predictors for successful performance in mathematics, particularly, with regards to specific learning tasks. In addition, a comparison of the effect of students' knowledge or lack of knowledge of their learning style on performance should be conducted. Another investigation, a combination of learner characteristics (such as gender and ability) and their level of mathematics anxiety-apprehension may yield additional information about how students learn and process information. Finally, how learning styles and other learner characteristics influence performance in other instructional and non-instructional environments might be investigated as well. The differential effects of style-shifting for the at-risk students is also desirable. The classification of developmental learners within their cognitive circumflex and the cogno-abstract-concrete continuum is highly needed (Ikegulu, 1997). This research should focus on the combination of cognitive learning styles (field-dependent and field-independent) and the levels of mathematics anxiety-apprehension to determine students' academic and occupational preferences. Research efforts that investigate this

classification would provide missing information about the "true nature and characteristics" of students. A potential comparison of this 'new' study with the literature on learning styles dimensions will bridge the gap between "what is known" and "what needs to be known" about this population of students in America's multiculturally and linguistically diverse classrooms.

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Table 1

Persistence Analysis: Stratum-Specific Summary Measures and Statistics by Gender and First-Generation Status

Stratum/ Factor	N	Number Events	Censored	Persistence Time Mean/SEM	Median	Percent RET.	ATT.
(A) Gender and First-Generation Status Main Effects							
Gender							
Male	111	60	51	34.50/1.30	36.00	45.95	54.05
Female	133	71	62	35.38/1.78	34.38	46.62	53.38
Overall	244	131	113			46.31	53.69

Statistics	Value	df	P-Value
Log Rank Statistic for the Difference Persistence Distributions:	0.28	1	0.598
Breslow Statistic for the Difference in Attrition Rates:	1.49	1	0.222
Tarone-Ware Statistic for the Concordance in Attrition Rates:	1.36	1	0.262

First-Generation Status							
Yes	91	44	47	36.67/1.95	39.70	51.65	48.35
Not	153	87	66	34.03/1.42	34.56	43.14	56.86
Overall	244	131	113			46.31	53.69

Statistics	Value	df	P-Value
Log Rank Statistic for the Difference Persistence Distributions:	2.48	1	0.116
Breslow Statistic for the Difference in Attrition Rates:	0.50	1	0.479
Tarone-Ware Statistic for the Concordance in Attrition Rates:	1.22	1	0.270

Table 1 (Continues)

Table 1 (Continued)

Stratum/ Factor	N	Number Events	Censored	Persistence Time Mean/SEM	Median	Percent RET.	ATT.
(B) Gender Stratified by First-Generation Status							
Male	111	60	51	34.50/1.30	36.00	45.95	54.05
Yes	47	22	25	35.67/2.11	39.32	53.19	46.81
Not	64	49	40	33.68/1.67	39.32	40.63	59.67
Female	133	71	62	35.38/1.78	34.38	46.62	53.38
Yes	44	22	22	36.33/3.01	40.62	50.00	50.00
Not	89	49	40	34.30/2.12	34.38	44.94	55.06
Overall(Attrition-Free Persisters)							
	244	131	113			46.31	53.69

Statistics	Value	df	P-Value
Log Rank Statistic for the Difference Persistence Distributions:			
	2.09	1	0.148
Breslow Statistic for the Difference in Attrition Rates:			
	0.28	1	0.595
Tarone-Ware Statistic for the Concordance in Attrition Rates:			
	0.88	1	0.348

Note.
RET. Means Retention Rate.
ATT. Means Attrition Rate.
Yes mean First-Generation Student.
No means Non-First Generation Student.

Table 2

Summary of the ANOVA Procedures

Source	SS	df	MS	F*	Eta^2	Power	p
Model	1975.75	4	493.94	1852.43	0.969	0.999	0.000
Gender	1.54	1	1.54	5.76	0.023	0.667	0.023
GENERATION	0.57	1	0.57	2.13	0.009	0.306	0.146
ANXIETY	0.058	1	0.058	0.218	0.001	0.075	0.641
Error	64.008	240	0.267				
Total	2039.76	243					

Note.
GENERATION = Main effects due to First-Generation status.
ANXIETY = Main effects due to mathematics anxiety-apprehension.

APPENDICES

CODE #: _____

Student's Demographic/Biographic Information

Age: _____ ***OR*** Date of Birth: _____/_____/_____ (Month/Day/Year)

Gender: [1] Male [2] Female

Classification (Grade Level):
[1] Freshman [2] Sophomore [3] Junior [4] Senior

Ethnicity/Race: [1] White (Non-Hispanic) [2] Black (Non-Hispanic)
[3] Asian American [4] Hispanic American
[5] Indian/Native American [6] Others

High School GPA: _____

List all MATH and ENGLISH Course Taken in **HIGH SCHOOL**:

MATH: _____ **ENGLISH**: _____
_____ _____
_____ _____
_____ _____

My **American College Test** (ACT) and/or **Scholastic Aptitude Test** (SAT) Composite score(s):

[ ]COMPOSITE **ACT** SCORE: [ ]COMPOSITE **SAT** SCORE:

[1]	9 or Less	[1]	460 or Less
[2]	10 - 13	[2]	470 - 520
[3]	14 - 16	[3]	530 - 620
[4]	17 - 19	[4]	630 - 770
[5]	20 - 23	[5]	780 - 930
[6]	24 - 26	[6]	940 - 1050
[7]	27 - 29 or More	[7]	1060 - 1190 or More

Family Background:

I am from a (Circle Only One) _____ family system
[1] Single family (natural parent, mother or father)
[2] Two family (mother & father, adopted parents, Uncle/Aunt. Etc.)
[3] Two family (step-parents, God parents, etc.)

Number of people (including your parents) in your immediate family _____
Number of Brothers _____ Number of Sisters _____

How many of your siblings are in or attended college?
Number of Brothers _____ Number of Sisters _____

Mathematics Anxiety-Apprehension Survey (MAAS)

DIRECTIONS:
Below are a series of statements about mathematics. There are no right or wrong answers to these statements. Please think about each statement by itself and answer with the number of the response that truly applies to you, and not what you would like to be true. While some of these statements may seem repetitious, take your time, try to be as 'honest' as possible, and indicate the degree to which each statement applies to you by circling (O) whether you: [1] Strongly Agree, [2] Agree, [3] Uncertain or Unsure, [4] Disagree, or [5] Strongly Disagree.

1. I avoid mathematics courses	[1]	[2]	[3]	[4]	[5]
2. Taking a math test is a frightening experience for me	[1]	[2]	[3]	[4]	[5]
3. I do my math homework alone	[1]	[2]	[3]	[4]	[5]
4. My mind seems to go blank during math tests	[1]	[2]	[3]	[4]	[5]
5. I make low scores on my math assignments	[1]	[2]	[3]	[4]	[5]
6. I make low scores on most of my math tests	[1]	[2]	[3]	[4]	[5]
7. I am afraid to submit my math tests or assignments	[1]	[2]	[3]	[4]	[5]
8. Math formulas are difficult for me to remember during tests	[1]	[2]	[3]	[4]	[5]
9. I learn math by solving problems	[1]	[2]	[3]	[4]	[5]
10. I enjoy mathematics	[1]	[2]	[3]	[4]	[5]
11. I like seeing the steps I used to arrive at my solution	[1]	[2]	[3]	[4]	[5]
12. I am nervous about mathematics	[1]	[2]	[3]	[4]	[5]
13. I feel confident in my ability to solve math problems	[1]	[2]	[3]	[4]	[5]
14. I am no good at solving math problems	[1]	[2]	[3]	[4]	[5]
15. I have a special dislike for mathematics	[1]	[2]	[3]	[4]	[5]
16. I enjoy showing others how to solve math problems	[1]	[2]	[3]	[4]	[5]
17. I depend on my tutors for help in math	[1]	[2]	[3]	[4]	[5]
18. I don't want my math tests or assignments to be evaluated	[1]	[2]	[3]	[4]	[5]
19. Mathematics is an exciting course	[1]	[2]	[3]	[4]	[5]
20. Most of my courses are math related	[1]	[2]	[3]	[4]	[5]
21. I feel a lot of pressure taking a math course	[1]	[2]	[3]	[4]	[5]
22. I generally cram a lot of information before a math test	[1]	[2]	[3]	[4]	[5]
23. It is difficult for me to understand math instructions	[1]	[2]	[3]	[4]	[5]
24. Mathematics comes easy for me	[1]	[2]	[3]	[4]	[5]
25. Mathematics is a boring subject	[1]	[2]	[3]	[4]	[5]
26. I feel a lot of stress taking a math test	[1]	[2]	[3]	[4]	[5]
27. Mathematics is one of my favorite subjects	[1]	[2]	[3]	[4]	[5]

28. I am fond of mathematics logic	[1]	[2]	[3]	[4]	[5]
29. Learning and understanding math can be fun	[1]	[2]	[3]	[4]	[5]
30. I always do well on math exams	[1]	[2]	[3]	[4]	[5]
31. My peers seem to understand me better than the teacher	[1]	[2]	[3]	[4]	[5]
32. I blame myself for my poor performance in mathematics	[1]	[2]	[3]	[4]	[5]
33. It is difficult for me to grasp math concepts	[1]	[2]	[3]	[4]	[5]
34. I like answering math questions in class	[1]	[2]	[3]	[4]	[5]
35. I volunteer myself to solve math problems on the board	[1]	[2]	[3]	[4]	[5]
36. Mathematics is one of my worst subjects	[1]	[2]	[3]	[4]	[5]
37. Mathematics is a great challenge for me	[1]	[2]	[3]	[4]	[5]
38. It is a joy to transform word problems into math expressions	[1]	[2]	[3]	[4]	[5]
39. It takes me a while to solve a math problem	[1]	[2]	[3]	[4]	[5]
40. Doing workbook exercises help improve my math scores	[1]	[2]	[3]	[4]	[5]